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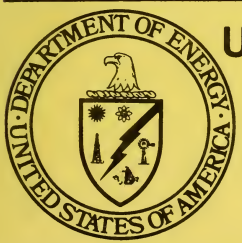
Aleph 1205908

SOLAR/1029-79/04

Monthly Performance Report

DESIGN CONSTRUCTION

APRIL 1979



U.S. Department of Energy

National Solar Heating and Cooling Demonstration Program

National Solar Data Program

4284

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MONTHLY PERFORMANCE REPORT

DESIGN CONSTRUCTION

APRIL 1979

I. SYSTEM DESCRIPTION

The Design Construction site is a single-family residence in Bigfork, Montana. The home has approximately 1800 square feet of conditioned space. Solar energy is used for space heating the home and preheating domestic hot water (DHW). The solar energy system has an array of flat-plate collectors with a gross area of 792 square feet. The array faces south at an angle of 45 degrees to the horizontal. Water is the transfer medium that delivers solar energy from the collector array to storage and from storage to the space heating and hot water loads. This water is drained from the collector when the collector pump is not operating. Solar energy is stored in a 1400-gallon water tank located in the conditioned space. The cylindrical tank has 6-inch concrete walls with 2-inch expanded polyurethane insulation. Preheated city water is stored in a 65-gallon DHW tank. When solar energy is insufficient to satisfy the space heating load, an electrical heating element in the boiler provides auxiliary energy for space heating. Similarly, an electrical heating element in the DHW tank provides auxiliary energy for water heating. Solar energy in the storage tank is supplemented by auxiliary energy provided by a hydro-heater fireplace which has a heat-exchanger water jacket around the chimney. When the fireplace is used, water is circulated from the storage tank through the fireplace and chimney heat exchanger, thereby accumulating additional energy which is returned to the storage tank. Energy from the storage tank is transferred to the DHW tank through an in-tank heat exchanger. Hot water used for space heating is passed from storage through the electric boiler and then through a four-zone hydronic heating system. Two fans are installed in the small enclosed chamber above the fireplace in which the fireplace pump (P4) and the fireplace control sensor are located. These fans are used to cool the chamber ambient and to circulate the warm chamber air into the living space. Both fans operate in parallel with the fireplace pump. The system, shown schematically in Figure 1, has four modes of solar operation, each of which is independent of the others.

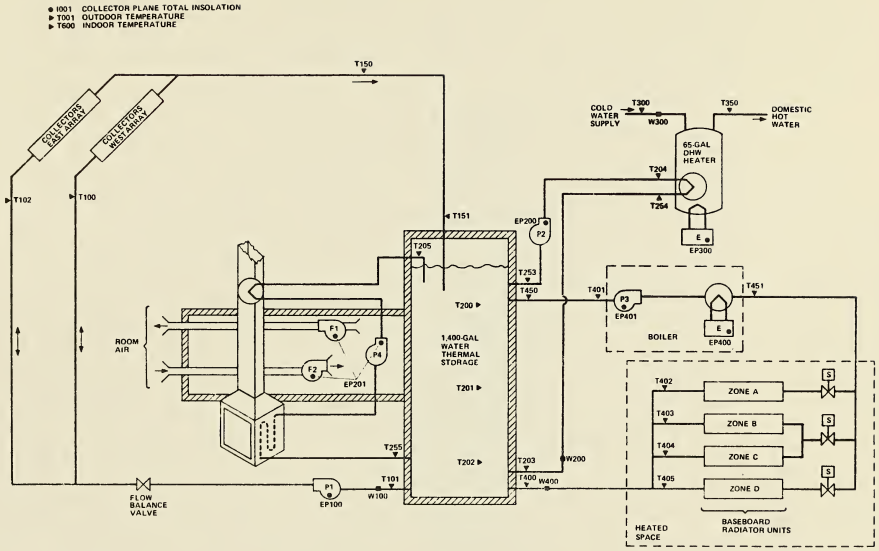

Figure 1. DESIGN CONSTRUCTION ASSOCIATES SOLAR ENERGY SYSTEM SCHEMATIC

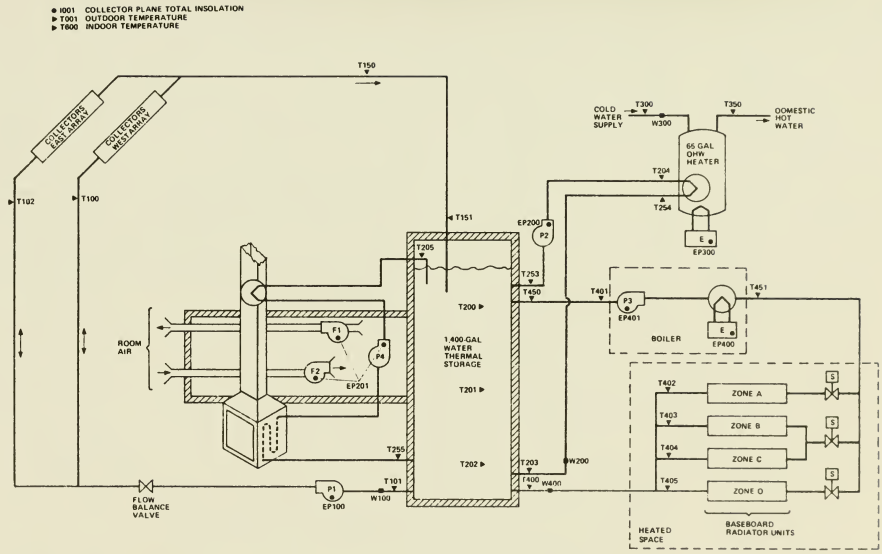

Figure 1. DESIGN CONSTRUCTION ASSOCIATES SOLAR ENERGY SYSTEM SCHEMATIC

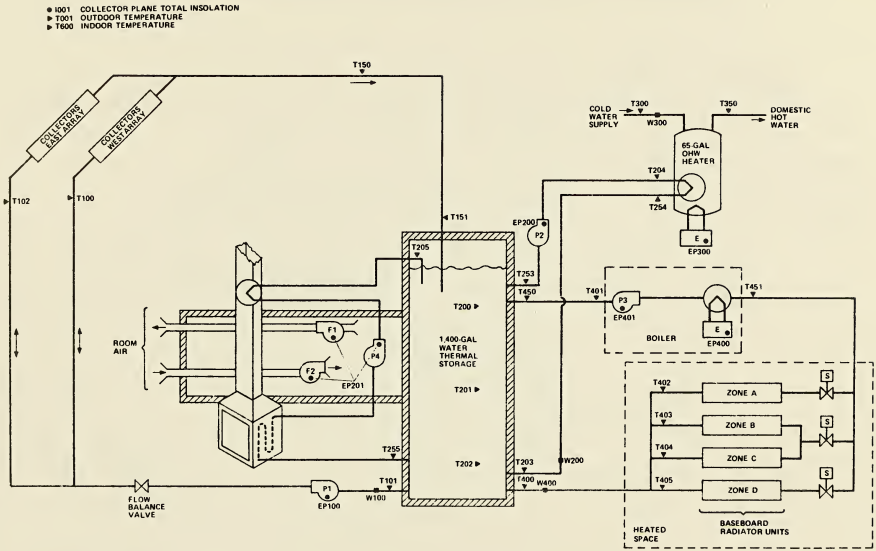

Figure 1. DESIGN CONSTRUCTION ASSOCIATES SOLAR ENERGY SYSTEM SCHEMATIC

Mode 1 - Collector-to-Storage: This mode activates when there is a temperature difference of 9°F between the control sensor located in the collector and the control sensor in the storage tank. Water is circulated from the storage tank through the collector and back to the tank. This circulation continues until the temperature difference between the two control sensors decreases to 3°F, at which point the circulating pump turns off. When the pump stops operating, water is drained from the collector and returned to the storage tank.

Mode 2 - Storage-to-Space Heating: This mode activates when any of the four zones demand space heating. The thermostat of the zone demanding heat will activate the solenoid-operated control valve for that zone. The thermostat will also activate the circulating pump to allow heated water to circulate from the storage tank, through the boiler, to the appropriate zone (via its control valve) and back to the storage tank. Water continues to circulate as long as any zone demands heat. The electric boiler will provide auxiliary energy if the temperature of the water circulating through the boiler drops below 110°F (set point). When the space heating demand is satisfied, the circulating pump turns off and all open-zone control valves close.

Mode 3 - Storage-to-DHW Heat Exchanger: This mode activates when the temperature difference between a control sensor in the storage tank and a control sensor on the surface of the DHW tank reaches 9°F and terminates when the temperature difference drops to 5°F. If the water temperature in the hot water tank falls below the setting of its thermostat, the electric immersion heater turns on to provide auxiliary energy to the water in the hot water tank. This mode also terminates if the temperature in the storage tank, as indicated by another control sensor in the storage tank, falls below 80°F (set point).

Mode 4 - Fireplace-to-Storage: This mode activates when there is a temperature difference of 9°F between a control sensor located in the fireplace and another control sensor in the storage tank. (This occurs when the fireplace is being used.) The pump turns on to circulate water from the storage tank through the fireplace and the chimney heat exchanger, thereby accumulating

energy which is returned to storage. This mode continues until the temperature difference between the two control sensors drops to 3°F, at which point the pump turns off and the mode terminates. Both fans in the enclosed chamber above the fireplace also operate in parallel with the pump while in this mode.

II. PERFORMANCE EVALUATION

INTRODUCTION

The site was occupied in April and the solar energy system operated continuously during the month. Solar energy satisfied 57 percent of the DHW requirements and 61 percent of the space heating requirements. The solar energy system provided an electrical energy savings of 4.8 million Btu. Flow sensor anomaly caused the calculated space heating load to be higher than it actually was for the first 11 days of the month. During the remainder of the month, the flow had to be estimated during intermittent failure of the same sensor. These anomalies also contributed to the erroneously high value for storage efficiency. The performance factors are discussed below and presented in the accompanying report forms.

WEATHER CONDITIONS

During the month, total incident solar energy on the collector array was 27.5 million Btu for a daily average of 1157 Btu per square foot. This was below the estimated average daily solar radiation for this geographical area during April of 1612 Btu per square foot for a south-facing plane with a tilt of 45 degrees to the horizontal. The average ambient temperature during April was 41°F as compared with the long-term average for April of 42°F. The number of heating degree-days for the month (based on a 65°F reference) was 681, as compared with the long-term average of 690.

THERMAL PERFORMANCE

System - During April the solar energy system performed approximately the same as expected. The expected performance was determined from a modified f-chart analysis using measured weather and subsystem loads as inputs. Solar energy collected was 8.2 million Btu versus an estimated 5.8 million Btu. Solar energy used by the system was estimated by assuming that all energy collected would be applied to the load. Actual solar energy used was 5.0 million Btu. System total solar fraction was 60 percent versus an estimated 71 percent.

Collector - The total incident solar radiation on the collector array for the month of April was 27.5 million Btu. During the period the collector loop was operating, the total insolation amounted to 20.6 million Btu. The total collected solar energy for the month of April was 8.2 million Btu, resulting in a collector array efficiency of 30 percent, based on total incident insolation. Solar energy delivered from the collector array to storage was 5.1 million Btu. Energy loss during transfer from the collector array to storage was 3.1 million Btu. This loss represented 38 percent of the energy collected. Operating energy required by the collector loop was 0.12 million Btu.

Storage - Solar energy delivered to storage was 5.1 million Btu and auxiliary energy contribution to storage from the fireplace was 0.87 million Btu. There were 10.5 million Btu delivered from storage to the DHW and space heating subsystems. The storage efficiency was 189 percent: This is calculated as the ratio of the sum of the energy removed from storage and the change in stored energy, to the energy delivered to storage. The average storage temperature for the month was 134°F.

DHW Load - The DHW subsystem consumed 2.3 million Btu of solar energy, 0.73 million Btu of auxiliary energy from storage and 0.77 million Btu of auxiliary electrical energy to satisfy a hot water load of 1.7 million Btu. The solar fraction of this load was 57 percent. Losses from the DHW subsystem were 2.1 million Btu. The DHW subsystem consumed a total of 0.10 million Btu of operating energy, resulting in an electrical energy savings of 2.2 million Btu. A daily

average of 70 gallons of DHW was consumed at an average temperature of 149°F delivered from the tank.

Space Heating Load - The space heating subsystem consumed 2.7 million Btu of solar energy and 1.8 million Btu of auxiliary energy from storage in order to satisfy a space heating load of 4.4 million Btu. The solar fraction of this load was 61 percent. Losses from the space heating subsystem were 0.069 million Btu. The space heating subsystem consumed a total of 0.039 million Btu of operating energy, resulting in an electrical energy savings of 2.6 million Btu.

OBSERVATIONS

Problems with the flowmeter (W400) of the storage/space heating loop continued throughout the month. A Boeing site visit on April 11 resulted in removal of debris in the meter. This debris caused the flowmeter to stick intermittently and to give erroneous high readings. However, on April 14 the same meter intermittently indicated zero flow even through data shows that the related pump (P3) was operating. Sensor failure occurs on approximately 28 percent of the scans when flow does occur. An estimated flow value was used on the scans where W400 failed. Therefore, performance factors derived from this flow (energy output from storage and heating load) have higher values than actual readings during the first 11 days of the month and are based, in part, on estimated flows during the remainder of the month.

Storage efficiency continued to exceed 100 percent by a considerable amount and contributed to the high value for energy output from storage (discussed above). Storage efficiency was 137 percent for the portion of the month following the flowmeter repair on April 11. Analysis will continue in order to determine the causes of the storage energy imbalance.

ENERGY SAVINGS

The solar energy system provided a net electrical energy savings of 4.8 million Btu. The DHW subsystem provided an electrical energy savings of 2.2 million Btu, while the space heating subsystem contributed an electrical energy savings of 2.6 million Btu.

III. ACTION STATUS

The flow sensor (W400) in the storage/space heating loop must be fixed. Boeing has not scheduled a site visit at this time.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
SITE SUMMARY

SITE: DESIGN CONSTRUCTION, BIG FORK, MONTANA SOLAR/1029-79/04
REPORT PERIOD: APRIL,1979

SITE/SYSTEM DESCRIPTION:
THE DESIGN CONSTRUCTION SOLAR ENERGY SYSTEM PROVIDES SPACE HEATING AND DOMESTIC HOT WATER. THE SOLAR ENERGY SYSTEM USES WATER AS THE COLLECTION, STORAGE AND TRANSFER MEDIUM. HOT WATER FROM THE STORAGE TANK IS TRANSFERRED TO THE DHW TANK THROUGH AN IN-TANK HX. ELECTRICAL ENERGY SUPPLIES AUXILIARY ENERGY FOR HEATING THE DHW. HOT WATER FROM THE STORAGE TANK FOR SPACE HEATING PASSES THROUGH AN ELECTRIC BOILER THEN THROUGH A FOUR ZONE HYDRONIC HEATING SYSTEM.

GENERAL SITE DATA:

INCIDENT SOLAR ENERGY	27.483	MILLION BTU
	34701	BTU/SQ.FT.
COLLECTED SOLAR ENERGY	8.245	MILLION BTU
	10410	BTU/SQ.FT.
AVERAGE AMBIENT TEMPERATURE	41	DEGREES F
AVERAGE BUILDING TEMPERATURE	71	DEGREES F
ECSS SOLAR CONVERSION EFFICIENCY	0.18	
ECSS OPERATING ENERGY	0.119	MILLION BTU
TOTAL SYSTEM OPERATING ENERGY	0.258	MILLION BTU
TOTAL ENERGY CONSUMED	10.250	MILLION BTU

SUBSYSTEM SUMMARY:

	HOT WATER	HEATING	COOLING	SYSTEM TOTAL
LOAD	1.708	4.359	N.A.	6.087 MILLION BTU
SOLAR FRACTION	57	61	N.A.	60 PERCENT
SOLAR ENERGY USED	2.341	2.668	N.A.	5.009 MILLION BTU
OPERATING ENERGY	0.100	0.039	N.A.	0.258 MILLION BTU
AUX. THERMAL ENERGY	1.496	1.760	N.A.	3.256 MILLION BTU
AUX. ELECTRIC FUEL	0.769	0.000	N.A.	0.769 MILLION BTU
AUX. FOSSIL FUEL	N.A.	N.A.	N.A.	N.A. MILLION BTU
ELECTRICAL SAVINGS	2.241	2.629	N.A.	4.758 MILLION BTU
FOSSIL SAVINGS	N.A.	N.A.	N.A.	N.A. MILLION BTU

SYSTEM PERFORMANCE FACTOR: 1.779

* DENOTES UNAVAILABLE DATA
@ DENOTES NULL DATA
N.A. DENOTES NOT APPLICABLE DATA

REFERENCE: USER'S GUIDE TO THE MONTHLY PERFORMANCE REPORT OF THE NATIONAL SOLAR DATA PROGRAM,FEBRUARY 28,1978, SOLAR/0004-78/18

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SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
SITE SUMMARY

SITE: DESIGN CONSTRUCTION, BIG FORK, MONTANA SOLAR/1029-79/04
REPORT PERIOD: APRIL,1979

SITE/SYSTEM DESCRIPTION:
THE DESIGN CONSTRUCTION SOLAR ENERGY SYSTEM PROVIDES SPACE HEATING AND DOMESTIC HOT WATER. THE SOLAR ENERGY SYSTEM USES WATER AS THE COLLECTION, STORAGE AND TRANSFER MEDIUM. HOT WATER FROM THE STORAGE TANK IS TRANSFERRED TO THE DHW TANK THROUGH AN IN-TANK HX. ELECTRICAL ENERGY SUPPLIES AUXILIARY ENERGY FOR HEATING THE DHW. HOT WATER FROM THE STORAGE TANK FOR SPACE HEATING PASSES THROUGH AN ELECTRIC BOILER THEN THROUGH A FOUR ZONE HYDRONIC HEATING SYSTEM.

GENERAL SITE DATA:

INCIDENT SOLAR ENERGY	28.994 GIGA JOULES
	394060 KJ/SQ.M.
COLLECTED SOLAR ENERGY	8.699 GIGA JOULES
	118222 KJ/SQ.M.
AVERAGE AMBIENT TEMPERATURE	5 DEGREES C
AVERAGE BUILDING TEMPERATURE	22 DEGREES C
ECSS SOLAR CONVERSION EFFICIENCY	0.18
ECSS OPERATING ENERGY	0.126 GIGA JOULES
TOTAL SYSTEM OPERATING ENERGY	0.272 GIGA JOULES
TOTAL ENERGY CONSUMED	10.814 GIGA JOULES

SUBSYSTEM SUMMARY:

	HOT WATER	HEATING	COOLING	SYSTEM TOTAL
LOAD	1.802	4.599	N.A.	6.421 GIGA JOULES
SOLAR FRACTION	57	61	N.A.	60 PERCENT
SOLAR ENERGY USED	2.470	2.815	N.A.	5.284 GIGA JOULES
OPERATING ENERGY	0.105	0.041	N.A.	0.272 GIGA JOULES
AUX. THERMAL ENG	1.578	1.857	N.A.	3.435 GIGA JOULES
AUX. ELECTRIC FUEL	0.812	0.000	N.A.	0.812 GIGA JOULES
AUX. FOSSIL FUEL	N.A.	N.A.	N.A.	N.A. GIGA JOULES
ELECTRICAL SAVINGS	2.364	2.774	N.A.	5.020 GIGA JOULES
FOSSIL SAVINGS	N.A.	N.A.	N.A.	N.A. GIGA JOULES

SYSTEM PERFORMANCE FACTOR: 1.779

* DENOTES UNAVAILABLE DATA
@ DENOTES NULL DATA
N.A. DENOTES NOT APPLICABLE DATA

REFERENCE: USER'S GUIDE TO THE MONTHLY PERFORMANCE REPORT OF THE NATIONAL SOLAR DATA PROGRAM,FEBRUARY 28,1978, SOLAR/0004-78/18

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SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
ENERGY COLLECTION AND STORAGE SUBSYSTEM (ECSS)

SITE: DESIGN CONSTRUCTION, BIG FORK, MONTANA
REPORT PERIOD: APRIL,1979

SOLAR/1029-79/04

DAY OF MONTH	INCIDENT SOLAR ENERGY MILLION BTU	AMBIENT TEMP DEG-F	ENERGY TO LOADS MILLION BTU	AUX THERMAL TO ECSS MILLION BTU	ECSS OPERATING ENERGY MILLION BTU	ECSS ENERGY REJECTED MILLION BTU	ECSS SOLAR CONVERSION EFFICIENCY
1	0.747	29	0.486	0.170	0.004	N	0.367
2	1.126	31	0.431	-0.000	0.006	O	0.205
3	0.452	35	0.497	0.270	0.002	T	0.605
4	0.334	38	0.457	0.093	0.001		0.684
5	1.175	44	1.021	0.000	0.006	A	0.437
6	1.010	43	0.149	-0.018	0.004	P	0.090
7	0.758	41	0.147	-0.000	0.003	P	0.123
8	1.247	43	0.240	0.000	0.007	L	0.130
9	0.159	38	0.084	0.065	0.000	I	0.365
10	0.260	33	0.641	0.230	0.002	C	1.609
11	1.821	36	0.379	-0.001	0.008	A	0.125
12	1.366	38	0.201	-0.014	0.005	B	0.107
13	0.461	39	0.121	-0.001	0.001	L	0.197
14	1.038	40	0.237	-0.009	0.005	E	0.171
15	0.904	40	0.132	-0.004	0.004		0.115
16	0.895	46	0.021	-0.004	0.003		0.019
17	1.071	45	0.264	0.000	0.005		0.207
18	1.006	39	0.176	-0.000	0.005		0.152
19	0.994	39	0.122	-0.003	0.004		0.108
20	1.069	38	0.103	0.000	0.004		0.086
21	1.341	40	0.123	-0.003	0.006		0.083
22	0.245	42	0.054	0.000	0.000		0.200
23	0.274	43	0.219	-0.001	0.000		0.731
24	0.840	41	0.096	0.042	0.007		0.102
25	0.914	42	0.181	-0.002	0.005		0.179
26	*	*	*	*	*		*
27	*	*	*	*	*		*
28	1.745	53	0.103	-0.004	0.007		0.054
29	1.368	51	0.102	0.000	0.005		0.069
30	1.032	49	0.208	0.000	0.004		0.189
SUM	27.483	-	7.495	0.865	0.119	N.A.	-
AVG	0.916	41	0.250	0.029	0.004	N.A.	0.182
NBS ID	Q001	N113			Q102		N111

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

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SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
COLLECTOR ARRAY PERFORMANCE

SITE: DESIGN CONSTRUCTION, BIG FORK, MONTANA SOLAR/1029-79/04
REPORT PERIOD: APRIL,1979

DAY OF MONTH	INCIDENT SOLAR ENERGY MILLION BTU	OPERATIONAL INCIDENT ENERGY MILLION BTU	COLLECTED SOLAR ENERGY MILLION BTU	DAYTIME AMBIENT TEMP DEG F	COLLECTOR ARRAY EFFICIENCY
1	0.747	0.465	0.164	31	0.220
2	1.126	0.996	0.467	*	0.415
3	0.452	0.038	-0.017	38	-0.039
4	0.334	0.000	0.000	40	0.000
5	1.175	1.014	0.450	*	0.383
6	1.010	0.821	0.336	*	0.332
7	0.758	0.527	0.229	45	0.302
8	1.247	1.102	0.408	51	0.327
9	0.159	0.000	0.000	*	0.000
10	0.260	0.000	0.000	35	0.000
11	1.821	1.662	0.645	42	0.354
12	1.366	1.077	0.615	43	0.450
13	0.461	0.165	0.008	*	0.017
14	1.038	0.807	0.226	44	0.218
15	0.904	0.693	0.259	45	0.286
16	0.895	0.599	0.239	51	0.267
17	1.071	0.943	0.476	47	0.445
18	1.006	0.797	0.317	45	0.315
19	0.994	0.860	0.307	*	0.309
20	1.069	0.818	0.322	42	0.301
21	1.341	1.066	0.339	47	0.253
22	0.245	0.000	0.000	*	0.000
23	0.274	0.023	-0.008	44	-0.030
24	0.840	0.701	0.267	47	0.318
25	0.914	0.689	0.266	*	0.291
26	*	*	*	*	*
27	*	*	*	*	*
28	1.745	1.489	0.589	62	0.338
29	1.368	1.092	0.458	62	0.335
30	1.032	0.803	0.336	56	0.325
SUM	27.483	20.622	8.245	-	-
AVG	0.916	0.687	0.275	46	0.300
NBSID	Q001		Q100		N100

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

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SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
STORAGE PERFORMANCE

SITE: DESIGN CONSTRUCTION, BIG FORK, MONTANA SOLAR/1029-79/04
REPORT PERIOD: APRIL,1979

DAY OF MONTH	ENERGY TO STORAGE MILLION BTU	ENERGY FROM STORAGE MILLION BTU	CHANGE IN STORED ENERGY MILLION BTU	STORAGE AVERAGE TEMP DEG F	STORAGE EFFICIENCY
1	0.201	0.564	0.213	111	3.860
2	0.307	0.503	-0.013	116	1.596
3	0.235	0.622	0.153	121	3.301
4	0.093	0.566	-0.053	124	5.494
5	0.311	1.186	0.088	126	4.092
6	0.230	0.279	0.082	138	1.565
7	0.126	0.241	-0.048	134	1.537
8	0.267	0.351	0.080	138	1.617
9	0.065	0.183	-0.079	136	1.603
10	0.230	0.750	-0.042	128	3.083
11	0.459	0.499	0.230	140	1.588
12	0.340	0.377	0.010	151	1.140
13	-0.001	0.240	-0.213	140	-20.385
14	0.135	0.310	-0.016	130	2.178
15	0.176	0.227	0.019	133	1.398
16	0.140	0.063	0.027	135	0.643
17	0.339	0.355	-0.022	134	0.985
18	0.218	0.282	-0.007	132	1.259
19	0.171	0.174	0.009	132	1.070
20	0.201	0.197	0.045	134	1.205
21	0.180	0.232	0.044	141	1.529
22	0.000	0.084	-0.155	135	1.000
23	-0.017	0.269	-0.202	119	-3.928
24	0.181	0.137	0.096	114	1.287
25	0.145	0.250	0.011	119	1.803
26	*	*	*	*	*
27	*	*	*	*	*
28	0.316	0.258	0.497	163	2.387
29	0.298	0.246	0.029	165	0.923
30	0.211	0.351	-0.076	164	1.304
SUM	5.955	10.497	0.760	-	-
AVG	0.199	0.350	0.025	134	1.890
NBS ID	Q200	Q201	Q202		N108

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

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SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
HOT WATER SUBSYSTEM

SITE: DESIGN CONSTRUCTION, BIG FORK, MONTANA
REPORT PERIOD: APRIL,1979

SOLAR/1029-79/04

DAY OF MON.	HOT WATER LOAD MILLION BTU	SOLAR FR.OF LOAD PER CENT	SOLAR ENERGY USED MILLION BTU	OPER ENERGY MILLION BTU	AUX THERMAL USED MILLION BTU	AUX ELECT FUEL MILLION BTU	AUX FOSSIL FUEL MILLION BTU	ELECT ENERGY SAVINGS MILLION BTU	FOSSIL ENERGY SAVINGS MILLION BTU	SUP. WAT. TEMP DEG F	HOT WAT. TEMP DEG F	HOT WATER USED GAL
1	0.036	27	0.038	0.003	0.065	0.032	N	0.035	N	61	147	40
2	0.081	37	0.053	0.002	0.080	0.043	O	0.050	O	59	151	91
3	0.080	40	0.086	0.004	0.124	0.049	T	0.081	T	56	152	90
4	0.077	37	0.048	0.004	0.088	0.041		0.044		62	146	101
5	0.094	37	0.065	0.004	0.103	0.046	A	0.060	A	66	146	125
6	0.078	50	0.091	0.004	0.077	0.019	P	0.086	P	63	149	90
7	0.035	51	0.030	0.003	0.031	0.013	P	0.026	P	70	146	41
8	0.046	55	0.079	0.003	0.054	0.020	L	0.076	L	63	146	54
9	0.028	56	0.029	0.003	0.022	0.009	I	0.026	I	66	147	31
10	0.043	51	0.039	0.003	0.046	0.024	C	0.036	C	58	152	49
11	0.036	51	0.059	0.003	0.046	0.014	A	0.056	A	58	152	41
12	0.085	63	0.137	0.006	0.067	0.017	B	0.131	B	63	150	97
13	0.019	66	0.040	0.004	0.022	0.008	L	0.036	L	69	146	24
14	0.057	58	0.050	0.003	0.043	0.027	E	0.047	E	63	151	65
15	0.059	59	0.092	0.004	0.056	0.032		0.088		59	151	74
16	0.010	62	0.017	0.001	0.012	0.008		0.016		68	147	13
17	0.134	64	0.188	0.004	0.096	0.061		0.184		62	147	166
18	0.099	68	0.153	0.004	0.070	0.047		0.148		63	151	129
19	0.044	70	0.076	0.002	0.032	0.021		0.073		63	154	50
20	0.036	67	0.076	0.004	0.029	0.020		0.072		59	152	42
21	0.041	73	0.079	0.004	0.021	0.013		0.075		68	147	50
22	0.023	73	0.024	0.001	0.015	0.013		0.023		57	151	29
23	0.047	65	0.049	0.002	0.032	0.027		0.047		67	147	56
24	0.080	51	0.078	0.002	0.066	0.057		0.076		65	149	110
25	0.098	60	0.124	0.003	0.071	0.058		0.120		65	147	136
26	*	*	*	*	*	*		*		*	*	*
27	*	*	*	*	*	*		*		*	*	*
28	0.029	84	0.095	0.004	0.009	0.000		0.090		64	154	34
29	0.029	90	0.094	0.004	0.008	0.000		0.091		62	152	36
30	0.073	93	0.198	0.004	0.013	0.000		0.195		60	154	89
SUM	1.708	-	2.341	0.100	1.496	0.769	N.A.	2.241	N.A.	-	-	2092
AVG	0.057	57	0.078	0.003	0.050	0.026	N.A.	0.075	N.A.	63	149	70
NBS	Q302	N300	Q300	Q303	Q301	Q305	Q306	Q311	Q313	N305	N307	N308

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

4284

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
SPACE HEATING SUBSYSTEM

SITE: DESIGN CONSTRUCTION, BIG FORK, MONTANA
REPORT PERIOD: APRIL,1979

SOLAR/1029-79/04

DAY OF MON.	SPACE HEATING LOAD MILLION BTU	SOLAR FR.OF LOAD PCT	SOLAR ENERGY USED MILLION BTU	OPER ENERGY MILLION BTU	AUX THERMAL USED MILLION BTU	AUX ELECT FUEL MILLION BTU	AUX FOSSIL FUEL MILLION BTU	ELECT ENERGY SAVINGS MILLION BTU	FOSSIL ENERGY SAVINGS MILLION BTU	BLDG TEMP DEG. F	AMB TEMP DEG. F
1	0.411	57	0.236	0.004	0.179	0.000	N	0.233	N	67	29
2	0.347	51	0.178	0.003	0.163	0.000	O	0.175	O	70	31
3	0.334	56	0.187	0.002	0.149	0.000	T	0.185	T	69	35
4	0.351	52	0.181	0.002	0.182	0.000		0.179		67	38
5	0.884	51	0.449	0.005	0.450	0.000	A	0.444	A	73	44
6	0.000	0	0.000	0.000	0.000	0.000	P	0.000	P	73	43
7	0.100	64	0.064	0.000	0.036	0.000	P	0.063	P	71	41
8	0.113	74	0.083	0.000	0.044	0.000	L	0.083	L	72	43
9	0.031	102	0.029	0.000	0.014	0.000	I	0.029	I	70	38
10	0.582	65	0.380	0.004	0.200	0.000	C	0.376	C	69	33
11	0.279	57	0.169	0.002	0.119	0.000	A	0.166	A	72	36
12	0.013	72	0.010	0.000	0.004	0.000	B	0.009	B	72	38
13	0.068	74	0.050	0.001	0.017	0.000	L	0.049	L	71	39
14	0.164	78	0.127	0.002	0.043	0.000	E	0.125	E	72	40
15	0.015	82	0.013	0.000	0.004	0.000		0.012		72	40
16	0.000	0	0.000	0.000	0.000	0.000		0.000		72	46
17	0.040	84	0.034	0.001	0.007	0.000		0.033		74	45
18	0.000	0	0.000	0.000	0.000	0.000		0.000		73	39
19	0.037	85	0.032	0.001	0.005	0.000		0.031		73	39
20	0.018	87	0.016	0.001	0.002	0.000		0.015		72	38
21	0.033	97	0.032	0.000	0.004	0.000		0.032		72	40
22	0.028	88	0.024	0.001	0.032	0.000		0.024		70	42
23	0.175	87	0.152	0.005	0.014	0.000		0.147		70	43
24	0.009	84	0.008	0.000	0.001	0.000		0.007		71	41
25	0.041	95	0.039	0.000	0.005	0.000		0.039		70	42
26	*	*	*	*	*	*		*		*	*
27	*	*	*	*	*	*		*		*	*
28	0.000	0	0.000	0.000	0.000	0.000		0.000		76	53
29	0.000	0	0.000	0.000	0.000	0.000		0.000		76	51
30	-0.006	0	-0.003	0.000	-0.000	0.000		-0.003		73	49
SUM	4.359	-	2.668	0.039	1.760	0.000	N.A.	2.629	N.A.	-	-
AVG	0.145	61	0.089	0.001	0.059	0.000	N.A.	0.088	N.A.	71	41
NBS	Q402	N400	Q400	Q403	Q401		Q410	Q415	Q417	N406	N113

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SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
ENVIRONMENTAL SUMMARY

SITE: DESIGN CONSTRUCTION, BIG FORK, MONTANA
REPORT PERIOD: APRIL,1979

SOLAR/1029-79/04

DAY OF MONTH	TOTAL INSOLATION BTU/SQ.FT	DIFFUSE INSOLATION BTU/SQ.FT	AMBIENT TEMPERATURE DEG F	DAYTIME AMBIENT TEMP DEG F	RELATIVE HUMIDITY PERCENT	WIND DIRECTION DEGREES	WIND SPEED M.P.H.
1	943	N	29	31	N	N	N
2	1422	O	31	*	O	O	O
3	570	T	35	38	T	T	T
4	422		38	40			
5	1484	A	44	*	A	A	A
6	1276	P	43	*	P	P	P
7	957	P	41	45	P	P	P
8	1574	L	43	51	L	L	L
9	200	I	38	*	I	I	I
10	329	C	33	35	C	C	C
11	2299	A	36	42	A	A	A
12	1725	B	38	43	B	B	B
13	581	L	39	*	L	L	L
14	1310	E	40	44	E	E	E
15	1141		40	45			
16	1131		46	51			
17	1353		45	47			
18	1271		39	45			
19	1254		39	*			
20	1350		38	42			
21	1693		40	47			
22	309		42	*			
23	346		43	44			
24	1060		41	47			
25	1154		42	*			
26	*		*	*			
27	*		*	*			
28	2203		53	62			
29	1727		51	62			
30	1303		49	56			
SUM	34701	N.A.	—	—	—	—	—
AVG	1157	N.A.	41	46	N.A.	N.A.	N.A.
NBS ID	Q001		N113			N115	N114

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